PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :
B32B 31/12

A1

(11) International Publication Number: WO 89/ 00919

(43) International Publication Date: 9 February 1989 (09.02.89)

(21) International Application Number: PCT/US88/02494

(22) International Filing Date: 27 July 1988 (27.07.88)

(31) Priority Application Number: 078,385

(32) Priority Date: 27 July 1987 (27.07.87)

(33) Priority Country: US

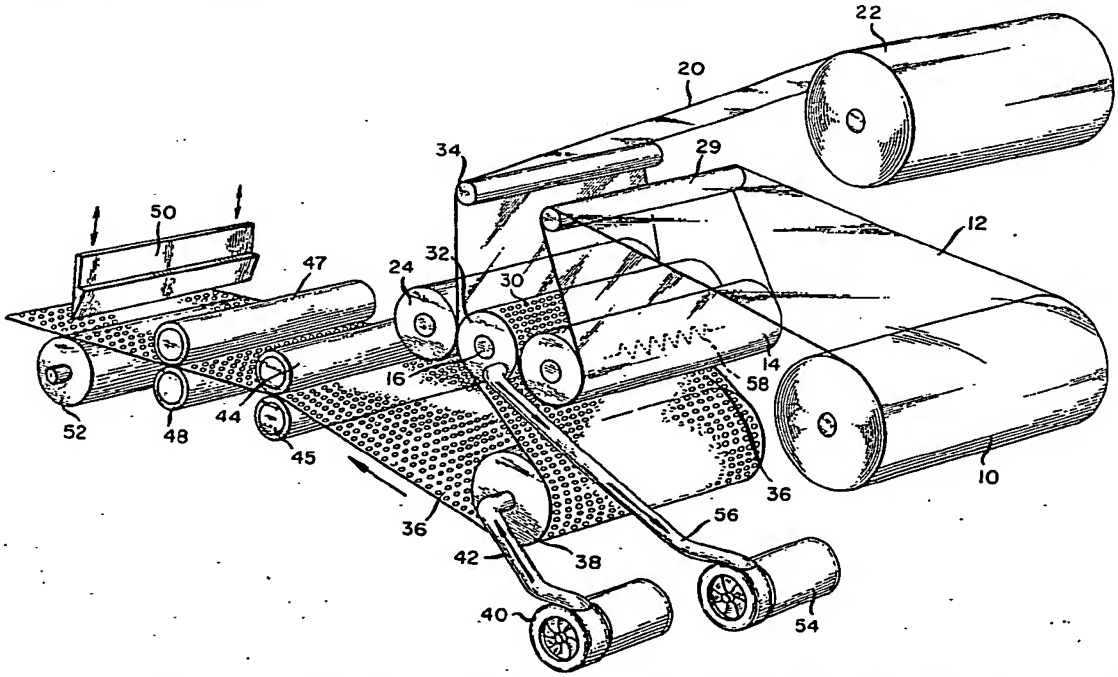
(71)(72) Applicant and Inventor: CAPUTO, Garry, L. [US/US]; 464 Riverside Avenue, Rutherford, NJ 07070 (US).

(74) Agents: KENNEY, J., Ernest et al.; Bacon & Thomas, 625 Slaters Lane - Fourth Floor, Alexandria, VA 22314 (US).

(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent).

Published
With international search report.

(54) Title: APPARATUS FOR PRODUCING AIR-CUSHIONING PRODUCT



(57) Abstract

An apparatus for forming thin air-cushioning material (36) including a first heated roller (14), a forming roller (16), a heated pressure roller (24), and a cooling roller (38) is disclosed. Two strips of thermoplastic material (12, 20) are fed to the heated rollers (14, 24), respectively. Thermoplastic material (12) is formed on the forming roller (16) which has cavities (30) connected to a vacuum source (54) by conduit (56). The outer periphery surface of the forming roller (16) has an attached resilient and insulating cover (32) which is absent the cavities (30). The two films (12, 20) are pressed and welded together at the nip formed between the pressure roller (24) and the forming roller (16) to form the material (36). The material (36) is then cooled on the cooling roller (38).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BG	Bulgaria
BJ	Benin
BR	Brazil
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

APPARATUS FOR PRODUCING AIR-CUSHIONING PRODUCT

This invention pertains to apparatus similar that disclosed by the Applicant in his U.S. Patents Nos. 4,576,669, as issued March 18, 1986, and entitled "On-Demand" Apparatus and Method For Producing Air-Cushioning Product, and 4,579,516, as issued April 1, 1986, and entitled Forming Roller For Producing Air-Cushioning Product. To the extent applicable, reference is made to these patents.

BACKGROUND OF THE INVENTION

Field of the Invention

With reference to the field of the invention, this invention is believed to be found in those patents classified by the United States Patent Office in the general class entitled "Adhesive Bonding and Miscellaneous Chemical Manufacture" and for air-cushioning products produced thereby.

DESCRIPTION OF THE PRIOR ART

Air-cushioning material is well known as packing dunnage both for its low cost and light weight and also for its convenience and strength. This dunnage

product utilizes flexible plastic sheet material and in the present invention is directed to and toward thermoplastic films in strip or roll form. The storage of the material in roll form is economical of space and cost and the present invention contemplates a capability leading to an almost immediate supply of cushioning material. The method and apparatus for producing such product includes a heat-sealable plastic sheet which is heated to bring a surface to a temperature in the proximity of fusion, welding or melting. This sheet is shaped by a multiplicity of cavities provided in an embossing drum or plate. Vacuum is used to form this sheet. Another sheet or strip of film is heated to a fusion or welding temperature and then laminated to the thermoformed sheet of film. The welding or laminating step anticipates that both films have their facing surfaces sufficiently heated to weld and pressure applied to form this weld, thus adhering the two films together. At least the temperatures of the film surfaces at the weld are sufficient for the weld to be achieved, and are of course equalized when fusion or welding is achieved.

There are many patents in the air-cell cushioning dunnage field, such as, for instance, Australian Patent No. 160,551, published October 29, 1953, and U.S. Pat. Nos. 3,018,015; 3,142,599; 3,231,454; 3,285,793; 3,349,990; 3,577,305; 3,389,534; 3,523,055; 3,575,781; 3,616,155; 3,785,899; 3,817,803; 3,837,990; 3,837,991; 3,868,056; 4,076,872; and 4,096,306. In addition, U.S. Patent Nos. 3,416,984 and 3,392,081 show basic construction methods, and U.S. Patent Nos. 4,415,398 and 4,427,474 show plural sheets and/or drum apparatus. In general, the prior art

apparatus contemplated is for high-volume/production and the resulting product is sold as big rolls or packages. Applicant's apparatus is for use by a manufacturer at and in his packing room. This apparatus is small and, more or less, self-contained. The simplicity of apparatus enables interruption of production and, when required, easy repair of the apparatus.

The known apparatus and methods do not anticipate the forming of air-cushioning product where the plies of thermoplastic film are less than one mil in thickness. The apparatus, to be more fully shown and described, has successfully produced an air-cushioning product where each ply of material is one-half mil (0.0005 inches) in thickness. This reduces cost in both manufacture and in the weight of air-cushioning product. This is very important where many items using such cushioning are shipped by air.

SUMMARY OF THE INVENTION

The invention of Applicant, to be described and illustrated hereinafter, provides apparatus and a method for the production of air-cushioning dunnage with flexible sheeting material supplied in roll form. The films are of high strength and high resistance to loss from the produced cells. The apparatus of this invention is small in size and can be interrupted conveniently in operation without destroying the desired product and its intended end use. If desired, the dunnage product can and may be stored in a small roll form.

This invention may be summarized, at least in part, with reference to its objects. It is an

object of this invention to provide, and it does provide, a novel apparatus and method for the production of air-cushioning dunnage in strip form with and of a flexible thermoplastic film requiring a minimum of apparatus.

It is a further object of this invention to provide, and it does provide, apparatus which is quite compact and with the forming roller having a thin coating of resilient silicone rubber that provides an insulating means to prevent the heated films from becoming cooled until lamination is made. This forming roller is provided with a vacuum conduit and an air-cool assist is provided for cooling.

It is a further object of this invention to provide, and it does provide, apparatus and method wherein the compact apparatus produces air-cushioning dunnage which can be interrupted in its production cycle and the cycle resumed without harm to the product or the apparatus and with minimum attention by an operator.

In brief, this apparatus employs very little room as it is designed for use in the packing or shipping room. Attendant time or skill is minimal for the operation of this apparatus in which supply is from two storage rolls of thermoplastic film. One or both films may be laminated films structured to inhibit air escape. The surfaces of the film are adapted to be softened so as to weld to another film with sufficient heat and pressure. A forming roll has cavities of a desired configuration and depth. Each cavity communicates to a manifold connected to a source of vacuum. One of the strips which is structured for thermoforming into pockets is fed to a heated roll to a whereat and whereon the advancing film is heated to a forming temperature. The film

passes from this heated roll to a forming roll having the cavity formations. The vacumm draws the softened and heated film strip into the formed cavities, and as this roll is coated with a thin sheet of silicone rubber, there is not only provided resiliency to accommodate irregularities in surface but also to provide insulation for loss of heat in these films. The shaped film is carried on this forming roll to the second heated film whereat the two heated films are pressed together at those areas around the cavities to form seals or welds at the interstices between pockets. After welding, the product is fed to a chill roll which sets the weld plies of film, after which the air-cushioning dunnage is cut to length for packing use or wound on an accumulating roll for storage for subsequent use.

There are shown two arrangements for novel apparatus for producing encapsulated air-cushioning materials at low cost with minimum moving parts at speeds substantially higher than for present apparatus for continuous motion thermoform and seal machine. This apparatus is unique as far as its ability to form and seal a variety of thermoplastic materials. These materials include unsupported polyethylene, polypropylene, PVC, acrylic, polyacrylonitrile, polyester, nylon, EVA, EMA, etc. It is also versatile in running structured materials as well, as for example PET/polyethylene homo-polymer or co-polymer and EMA, etc. The simplicity of this apparatus allows usage at the end user's level to produce an even lower cost air-cushioning product. This showing in one embodiment has no added cooling on the forming roll and is contemplated to accept and weld into air-cushion dunnage films in which each ply is less than one mil in thickness. One-half mil (0.0005

inches) thickness in each ply has been found to be practical. An alternate embodiment contemplates additional cooling for the forming roll, but an insulation and resilient covering of the forming roll is shown and contemplated.

In addition to the above summary, the following disclosure is detailed to insure adequacy and aid in understanding of the invention. This disclosure, however, is not intended to cover each new inventive concept no matter how it may be disguised later by variations in form or additions of further improvements. For this reason, there has been chosen a specific embodiment of the apparatus for producing air-cushioning dunnage for use in a shipping and/or storeroom as adopted for use for short-run operation and minimum operator attention and showing a preferred means for construction of the apparatus.

This specific embodiment has been chosen for the purposes of illustration and description as shown in the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 represents an isometric, partly diagrammatic, view of the apparatus and the relationship of the several components of this invention;

FIG. 2 represents a diagram of the apparatus and film supply of FIG. 1;

FIG. 3 represents a perspective view of the assembled apparatus of FIG. 1 and enclosed in and with supporting and associated guard portions;

FIG. 4 represents a plan view showing the positional relationship of the heated and forming rollers of FIG. 1;

FIG. 5 represents a side diagrammatic view of an alternate arrangement of apparatus used for extremely thin films;

FIG. 6 represents a side view, partly diagrammatic and in section, showing the construction of a forming roller;

FIG. 7 represents a small, greatly enlarged view of the roller of FIG. 6 and showing an outer construction of said roller;

FIG. 8 represents a diagrammatic end view, partly in section, showing the relationship of the end cover and roller;

FIG. 9 represents a sectional view of an alternate roller configuration with water-cooling capability, and

FIG. 10 represents an end view, partly diagrammatic and in section, to illustrate the roller of FIG. 9.

In the following description and in the claims, various details are identified by specific names for convenience. These names are intended to be generic in their application. Corresponding reference characters refer to like members throughout the several figures of the drawings.

The drawings accompanying, and forming part of, this specification disclose details of construction for the purpose of explanation, but structural details may be modified without departure from the concept and principles of the invention and the invention may be incorporated in other structural forms than shown.

EMBODIMENT OF FIGS. 1 AND 2

Referring next to the drawings and the apparatus depicted therein, the general arrangement of a first

embodiment is shown to illustrate the economy of components and of operation steps required for forming the air-cushioning material. From a supply roll 10, a web of film 12 is fed to and between a heated roll 14 and forming roll 16. Another strip of thermoplastic film 20 is carried by and on a supply roll 22 and is fed to heated roll 24. Both rolls 10 and 22 are rotatable on shaft means, and for the purposes of identification are numbered 26 and 28. The film 12 is carried to an idler roller 29 which is positioned so as to produce a wrap of about one hundred eighty degrees around heated roller 14. The idler roller 29 is usually carried on an adjustable arm (not shown) so that the wrap around roller 14 is adjusted to accommodate the thickness and character of films.

In FIG. 1, the film 20 carried in roll form is fed to metallic roll 24, which is heated by electrical energy. Thermostatic control of the temperature to establish the surface temperature and maintain this temperature throughout the cycle of operation is contemplated. Electrical energy is contemplated, but other means may be provided and no patentable distinction is ascribed thereto. Journal and shaft means for roll 24 are conventional and are not shown to reduce the descriptive explanation.

Roll 16 is diagrammatically shown in FIGS. 1 and 2 and is the air-cushioning forming roll which receives the heated film 12. With and by vacuum, this heated film is drawn into exposed cavities 30. This roller 16 is provided with a resilient silicone rubber outer covering 32. This covering is provided with shaped openings and is adhesively attached so that the multiplicity of cavities 30 is open to the heated film. This outer covering 32 is contemplated to be from thirty- to one hundred-thousandths of an

inch in thickness and, as shown in FIG. 7, is applied by adhesive to only the exterior of the roller 16. The coating of the cavities 30 is not desired, so spraying or dipping of the forming roller to provide the resilient coating is not practical. As seen in FIG. 2, the heated roller 24 is positioned so that the heated film 20 and the formed strip 12 are brought into a welding condition. It is to be noted that film 20 is brought to and around idler roller 34 so that a determined portion of film 20 is in contact with heated roller 24. Rollers 14 and 24, although heated, are also coated with Teflon (TM DuPont) in the conventionally known manner, with this treatment assisting in the ready release of heated films from the rollers.

Roll 16 is diagrammatically shown in FIGS. 1 and 2 with cavities 30 and with a resilient cover material 32. This roller 16 is precisely spaced from roller 24 so that films 12 and 20 are welded so as to produce an air-cushion dunnage strip identified as 36. This strip 36 proceeds to a lower roller 38 which is additionally cooled as by air flow produced by blower 40, with the stream carried in a conductor 42. This roller 38 may be, and preferably is, coated with Teflon for ready release. This air-cushion product dunnage strip 36 proceeds to above and below feed rollers 44 and 45. There is also depicted another downstream pair of feed rollers 47 and 48. Farther downstream is diagrammatically shown cut-off or severing means, depicted as a reciprocable knife 50, with a roller 52 providing an anvil surface for the sharpened knife edge to move to and effect the cut of the strip 36. It is to be noted in Fig. 1 that vacuum is produced by a pump 54, with a conductor 56

leading from the end of roller 16 to the pump 54. Also in this FIG. 1, electric resistance heating means 58 is suggested in the near roller 14. Like heating means is provided in roller 24.

EMBODIMENT OF FIG. 3

In FIG. 3, the apparatus of FIGS. 1 and 2 is shown in an enclosure and support frame as supplied to the customer. Rolls 22 and 10 are shown with shafts 28 and 26 as carried on a support stand 60 which may be a part of illustrated legs 62. The legs 62 have adjustability means so as to accommodate uneven floor areas. The support frame is shown with extending brackets having cutout means to receive and retain the shafts supporting the rolls. Idler roller 29 is depicted as supported on the near side with an arm 68. From roller 29, the film 12 proceeds to heated roller 14 as described above. The roller 16 is seen, as is also roller 24. Film 20 is fed to idler roller 34 as described above. The air-cushion material 36 is seen as proceeding to and from the apparatus.

Seen in this FIG. 3 is the outside case or enclosure which provides a guard of the mechanism, and is identified as 70. This enclosure has a front portion 71 in and on which is mounted simple switch means 72. This enclosure has a rear portion 73 which, as depicted, extends upwardly sufficiently to enclose drive and support means for the rollers and motor means. End members are also provided so as to enclose all working components. A near (left) end 74 is seen in this FIG. The outside case may be of suitable sheet metal or the like. This case is to provide a protector, preventing exposure of moving components to an attendant. Electrical components

are also insulated with control circuitry usually at and with twenty-four volts.

EMBODIMENT OF FIG. 4

FIG. 4 is a top view of the rollers shown in FIG. 1, 2 and 3 in which heated roller 14 is shown as carried on and by a shaft 76. This shaft is depicted as supported by frame members 77 and 78. The vacuum forming roller 16 is shown as spaced a short distance from roller 14 and is carried on a shaft 80, also journaled and supported in fixed relationship by frame members 77 and 78. This roller is shown with silicone rubber outer surface 32 and shaped cavities 30 (identified above). Roller 24, which is also heated, is in very close proximity to roller 16. The spacing between the peripheries of rollers 16 and 24 is adjusted so that pressing together of the two films 12 and 20 is achieved to effect a welding of the interstice portions. Roller 24 is shown as carried on and by shaft 82.

EMBODIMENT OF FIG. 5

In the apparatus shown in FIG. 5, the concept of FIGS. 1 and 2 is substantially duplicated, but this apparatus arrangement is for air-cushioning materials where the films are one mil (one-thousandth of an inch) or less. This arrangement is for films that are sufficiently thin for rapid cooling or heat loss. Rolls 10 and 22 are of thermoplastic films, with strips 12 and 20 fed to the idler rollers 29 and 34 substantially as in FIGS. 1 and 2. The heated film from roller 14 proceeds to the vacuum forming roller generally identified as 16, but the silicone rubber outer

cover 32 may be only about one thirty-second of an inch. This roller has vacuum produced by pump 54 and which is conducted by a substantially rigid pipe 56. This pipe conductor is attached to an end plate generally identified as 84. This end plate is figuratively shown as illustrative thereof and is non-rotative (fixed). This plate 84 includes an arcuate vacuum-conducting pathway 86 disposed to extend one-half the circle of the communication conductors leading to vacuum passages from the cavities 30. This particular construction is shown in greater detail and described hereinafter in FIGS. 6, 7 and 8. An added blower 88 and conductor 90 are illustrated, and it is noted that the air from this blower 88 is dispersed so as to cool the outer resilient surface of roller 16. It is also to be noted that roller 38 is shown as having a plurality of cooling passageways 92 which are supplied by air conductor 42 from blower 40. A distributor plate 94 is adapted to carry this air to the several passageways 92. It is to be noted that in this embodiment it is contemplated that only air and vacuum are utilized for the air-cushioning dunnage product. Severing or an accumulating roll for a stored product are a matter of preference and use.

EMBODIMENT OF FIGS. 6, 7 AND 8

The showing in FIGS. 6, 7 and 8 pertains to the apparatus of FIG. 5, but many of the concepts used therewith are also applicable to alternative embodiments. In FIG. 6, the roller, generally identified as 16, is depicted as having a resilient silicone rubber cover 32 interposed at all interstice areas. The cavities 30 are sized and

shaped to suit the desired air-cushioning sealed pocket. The inner ends of each cavity 30 are in flow communication with longitudinal conductors 96. The far or left end of each conductor is closed by a plug 98 so that only the right end is open to vacuum. This roller is shown as carried on and by shaft 80. The end plate 84 is provided with a wiping seal so that said arcuate pathway 86 is in flow communication with the vacuum pump 54 (FIG. 1) by means of conductor 56. It is to be noted that the arcuate pathway 86 as provided in plate 84 is contoured to extend to supply vacuum to only one-half of the conductors 96. As the roller 16 is rotated, one row of conductors 96 comes in way of pathway 86 and one row of conductors 96 moves into non-engagement. The heated film 12 leaving the roller 14 comes in the way of the cavities 30 and the vacuum to this row of cavities draws the heated film 12 into these cavities and holds the heated film to the roller 16 until the heated lidding film 20 is brought into a contiguous relationship. Roller 24 is spaced from roller 16 so that the heated films are welded together as air-cushioning material 36. The vacuum is non-effective after the weld has been completed and cavities 30 have moved from the weld area.

In FIG. 7, an enlarged (very fragmentary) view shows that the peripheral portion of roll 16 illustrates that formed cavities 30 have their inner extents in flow communication with longitudinal conductors 96. The outer interstice surface between cavities is covered with attached silicone rubber sheeting 32. This resilient cover 32 provides insulation to prevent unwanted cooling of the heated film 12 while being formed and while being brought to welding position.

In FIG. 8 is diagrammatically shown the roller of FIG. 6. This roller 16 is depicted with formed cavities 30 and therebetween are interstice portions with resilient covering 32 thereon. End plate 84 is shown with arcuate conductor 86 extending about one hundred eighty degrees. The resilient cover 32 and the cavities 30 are integral with the roll 16 as shown and rotates as the roll is moved. The cover 84 includes a wiper seal against the end of the revolving roller. This seal is not depicted as many are known and are conventionally used.

EMBODIMENT OF FIGS. 9 AND 10

In FIGS. 9 and 10 is shown an alternate construction of a forming roller. For the purpose of identification, this roller is generally identified as 100. This roller has water cooling depicted and indicates the forming rollers may be cooled with both air, vacuum and also with water. As seen and diagrammatically shown, an outer resilient tubular member is secured to a roller having a multiplicity of cavities 30 (FIG. 7) which conventionally are in line. These cavities extend to and through the resilient surface 32 of the tubular member 102. A gasket 106 is provided at each end of the member 104 to provide a seal of tubular member 104 to a contoured ring-end 108. Alignment and retention are provided by flat-heat screw members 110 which are shown as entered into threaded holes in member 102.

Another tubular member 112 is shown and provides an inner sleeve adapted to contain water or like fluid. It is noted that grooves 114 are made in this inner tubular member 112 and similar grooves are formed interior of member 104. These

grooves 114 and 116 are disposed opposite each other and retain a rubber seal 118, conventionally an extrusion of resilient material, and in position is compressed to a tight excluding fit and disposed lengthwise and extending to an end member 120 which is disposed at one end (left shown) and at the other end is a closed plate to close off the flow or action of vacuum. This end member 120, like end plate 84 (FIGS. 6 and 8), is formed with an arcuate vacuum-conducting portion 122. It is to be noted that the ring-end is formed with an inwardly-extending plug 124 disposed to engage and support tubular member 112 and also to provide a lengthwise stop. This plug is shown as supporting the inside of member 112, but the support of this inner member may be by other means and the length of member 112 and the diameter of plug 124 are merely a matter of selection. The arcuate conducting pathway 122 is only about one hundred eighty degrees. A shaft, identified as 126, has a water conductor 128 which is disposed so as to carry water into the cavity adjacent inner tubular member 112. A bearing 130 is depicted to prevent undue wear or scoring of the shaft 126 as it rotates relative to end member 120. A key 132 is suggested as a means of insuring that the roller 100 is rotated with and by the shaft 126. Vacuum is shown as connected to the arcuate conducting pathway 122. This vacuum conductor is, or is substantially, like conductor 56 seen in FIG. 5 described above.

It is realized that O-ring seals, not shown , or other means such as compounds may be used to prevent vacuum, water or fluid escape from the cavity portion to and along the inserted shaft. As the roller 100 and member 108 are secured together, it is also contemplated that a tight fit may be used

without a key 132 to insure positive rotation of the roller 100 by and with the shaft 126. Arrangements to suit the apparatus provided may be changed to accommodate the requirements of the product. It is also to be noted that the apparatus of FIGS. 1 and 5 illustrates the preferred arrangement of components. Downstream rollers are shown as a means for moving the air-cushioning material from cooling roller 38. Rollers 29 and 34 are shown as a preferred arrangement, but this is not definitive of the disclosed apparatus. The non-rotative end member (84, FIG. 6; 120, FIG. 10) may be of a plastic having anti-friction properties so that added bearing means between the shaft and end plate may not be required.

As the insulating and resilient portion 32 used on the forming roller provides a slowing barrier to the flow of heat to the roller, it is also a barrier to the cooling of the interior portion of the forming roller. The thickness of the film, the heating temperature to said film and the speed of travel is a needed evaluation and consideration for the arrangement of the components used in the apparatus. The vacuum to the forming cavities 30, auxiliary air cooing as shown in and by blower 88 in FIG. 5, and/or water cooling as in FIGS. 9 and 10 may be and is contemplated for conditioning temperatures as provided by the engineer of the apparatus. Where the air-cushioning material utilizes films thicker than two mils, the apparatus shown in Patent 4,576,669 (as identified above) is conventionally provided for such films. In the above specification, drawings and the claims of this invention, the pressure roller does not include a resilient covering, but the forming roller has an insulating resilient cover to accommodate the

pressure required for welding.

In the claims, thin plastic plies conventionally pertain to two-thousandths of an inch or less, with the above-described apparatus usually used with plies of one-half thousandth of an inch to slightly greater than one-thousandth of an inch. The forming roller with its resilient insulating outer covering is anticipated to accommodate temperatures of up to three hundred fifty degrees F. (158.9 degrees C.), depending on the film to be run. The positioning of the pressure roller 24 from the thermoforming roller 16 is adjustably provided to accommodate the thickness of the films. This means is usually pneumatic, as noted in the Patent No. 4,576,669 (above referenced), but other means may be provided.

As a method, this apparatus with the forming and production of air-cushioning materials anticipates that said material being from two rolls of thermoplastic material such as polyethylene or the like may be combined with other plastic materials to provide air passage-inhibiting properties; said method, providing means for a start and stop of the apparatus for manufacture and supplying of air-cushioning material, includes the steps of:

- providing a first roll of thin, thermoplastic film having thermoforming properties when heat-softened;
- carrying said roll on a supported shaft and as a continuous strip of film and replacing said roll on said shaft when replenishing the film on the first roll is desired or required;
- rotating and driving a first heat-conductive roller to and carrying on said roller the strip of first film around which the wrap extend is at least one hundred fifty degrees of arc;
- electrically heating said first film on

said first heat-conducting roll to a temperature between two hundred and two hundred sixty degrees F. (93.3 and 126.7 degrees C.) and with a thermostatic control of said first heat-conductive roller whereby and whereon the first film is heat-softened to a thermoforming condition;

- rotating a cooled, driven forming roller adjacent to and spacing said forming roller from the first heat-conducting roller so that non-contact is maintained with said first heat-conducting roller and providing between said first roller and said forming roller an S-path of heat-softened first film, said forming roller having its outer peripheral surface formed with a multiplicity of shaped cavities, and providing each cavity at its inner extent a small conductor leading to and terminating at a conductor and further connecting said conductor to source of vacuum;

- applying and securing a resilient and insulating covering of about one thirty-second to three thirty-seconds of an inch in thickness to said forming roller, this resilient cover absent from the multiplicity of formed cavities;

- carrying valve means in association with a conductor to said source of vacuum, and providing with this valve means a mask of a determined extent or sector therewith, and opening of about one-half of the small conductors from the shaped cavities to a source of vacuum so that the heat-softened first film is drawn by vacuum into these shaped cavities forming shaped cell forms, said resilient covering providing sufficient insulation that the now formed heat-softened plastic film is tightly carried thereon by vacuum;

- providing a second roll of thin, thermoplastic film as a lidding cover for the air-cushioning

- driving a second electrically-heated pressure roller and heating said roller to a selected temperature by electrical energy and providing on this roll a wrap of said film of said heated second roll of about ninety degrees of arc, said second lidding film heated to a welding condition, and with the second film in a wrap condition on said pressure roller said heat is sufficient that the peripheral temperature of the roller brings the second film to a temperature of at least two hundred seventy degrees F. (132.2 degrees C.) and while the first thermoformed and heated film is brought in way of this second heated, lidding film, pressing these films together into a welded condition, the cover on the driven forming roller sufficiently resilient so that with a minimum of applied pressure the second heated film is pressed to and into the first thermoformed film so that at the peripheral interstices between shaped cavities and at the outer surface of the forming roller and the welding is achieved, the peripheral speed of the driven pressure roller and the forming roller substantially in coincidence, the welding of the two plies of film material providing in the thermoformed air-cushioning material a multiplicity of air-encased cells of said first and second electrically heated rollers and maintaining the temperatures in the formed film and in the lidding material during welding;

- cooling a chill roll and positioning said roll so as to receive the welded strip of material and engaging said weld air-cushioning strip on the outer surface of said material, this cooling sufficient to bring the welded air-cushioning material to a temperature that is at or near room temperature, and

- carrying said cooled air-cushioning material

to accumulation means such as a storage roll or a packing table.

Welding pressure between rollers 16 and 24 is maintained by known means such a pneumatic cylinder or the like to move the pressure roll toward the forming roll. The forming roll is conventionally rotatably supported by and in bearing means so that the shaft is fixed in relation to the frame. As the films as to composition and thickness are variable, the pressure roll is controlled in its back-and-forth movement. Also, the heating is usually by a resistance element as it is one of the less expensive ways to thermostatically control the desired temperature. Alternate heating means such as radiation energy may be made practical so the claims and drawings are merely illustrative of electrical heating. The cooling of the thermoforming roll may be by means such as air or water or both. The cooling is controlled as to its capability and degree since the speed and type of film establishes the cooling required. The stripping of the air-cushioned product after welding is usually easily achieved since the air-cell cavities in the forming roller are usually of a tapered configuration, lending the formed cells themselves to easy removal. If the removal of the welded air-cushioning material from the forming roller is difficult, air may be used in conjunction with the small conductors and the arcuate valve means. A blast of air may also be used to assist in removal.

It is to be noted that the several rolls used in this apparatus are contemplated to be coated with an anti-adhesion material so that the film, whether heated or unheated, does not stick to the roll surfaces. This treatment is usually a baked-on

tetrafluorothylene (Teflon TM DuPont) or similar material which surface treatment is also of a high-heat resistance, well above the temperatures of the heated films used in the process described above.

Terms such as "left," "right," "up," "down," "bottom," "top," "front," "back," "in," "out," "clockwise," "counterclockwise" and the like are applicable to the embodiments shown and described in conjunction with the drawings. These terms are merely for the purposes of description and do not necessarily apply to the position in which the apparatus and method for producing air-cushioning product may be constructed or used.

While particular embodiments of the arrangement of the apparatus have been shown and described, it is to be understood that the invention is not limited thereto, and protection is sought to the broadest extent the prior art allows.

What is claimed is:

1. Apparatus for producing thin air-cushioning material, said material being formed from two layers of thermoplastic material supplied from rolls and which may be combined to provide air passage-inhibiting properties, this apparatus having control means for a start and stop of the apparatus by the operator and without alteration of the produced air-cushioning material, said apparatus including:

(a) a first roll of thin, thermoplastic film having thermoforming properties when heat-softened;

(b) means for carrying said roll on a supported shaft and as a continuous strip of film and means for replacing said roll on said shaft when replenishing of the first roll is desired or required;

(c) a first rotatable and driven heat-conductive roller to and toward which the strip of first film is carried and around which the wrap extent is at least one hundred fifty degrees of arc;

(d) means for electrically heating said first film on said first heat-conducting roll to a temperature between 93.3 and 126.7 degrees C. and including a thermostatic control of said first heat-conductive roller whereby and whereon the first film is heat-softened to a thermoforming conditoning;

(e) a driven rotatable forming roller adjacent to and spaced from the first heat-conducting roller, but in non-contact with said first heat-conducting roller and between said first roller and said forming roller providing an S-path of heat-softened first film, said forming roller having its outer peripheral surface formed with a multiplicity of shaped cavities, with each cavity having at its inner extent a small conduit leading to and terminating with a conduit which is connected to a source of vacuum;

(f) cooling means for cooling said forming roller;

(g) valve means in association with said conduit of said vacuum, this valve means providing a mask of a determined extent or sector to about one-half of the small conduits from the shaped cavities to said source of vacuum, the remaining shaped cavities open to air, said heat-softened first film wrapped against and on this forming roller so that said heat-softened first film when coming in contiguous contact with those cavities connected to said source of vacuum is drawn by vacuum into these shaped cavities forming shaped cell forms while the now formed first film is carried tightly on said forming roller by this vacuum;

(h) a resilient and insulating covering applied to and secured to the outer peripheral surface of the forming roller, this resilient covering being absent from the multiplicity of formed cavities and from one to three thirty-seconds of an inch in thickness;

(i) a second roll of thin, thermoplastic film providing a lidding cover for the air-cushioning material;

(j) a second rotatable driven heat-conductive pressure roller adapted to be heated to a selected temperature by electrical energy, this roll receiving the second film, and with a wrap of less than ninety degrees of arc heating this second film to a welding condition, and with the second film heated to a welding condition on said pressure roller the peripheral temperature of the roller and film is sufficient to bring the second film to a temperature of at least 132.2 degrees C. and while the first

thermoformed and heated film is brought in way of this second heated, lidding film, these films pressed together and into a welded condition so that with a minimum of applied pressure the second heated film engages the first thermoformed film at the peripheral interstices between shaped cavities and at the outer surface of the forming roller, the peripheral speed of the driven pressure roller and the forming roller substantially in coincidence, the weld of the two plies of film material providing in the thermoformed air-cushioning material a multiplicity of air-encased cells, said pressure roll movable toward and away from the forming roll and with the pressure adjustably applied and, once established maintained to provide a substantially constant pressure commensurate with the type and thicknesses of the films being welded;

(k) means for electrically heating said second driven pressure roller to a temperature by which the second film is heated and brought to a welding condition when wrapped on said roll, this temperature of the roll and the lidding film being established and maintained by thermostatic control;

(l) a chill roll and means for disposing and cooling said chill roll so as to receive the welded air-cushioning material and engage said material on the outer or lidding film surface and arranging the wrap of said welded air-cushioning product around and in contact with a substantial arcuate surface of said cooling chill roll so that said material is cooled to a temperature that is at or near room temperature;

(m) an idler roll disposed to accept and carry the material subsequent to the chill roll;

(n) accumulation means and means for carrying said air-cushioning material to said accumulation means; and,

(o) each of said driven pressure rolls having the same peripheral speed and including speed-adjusting means so as to provide an adjustable speed with an associated control means so that said films are drawn from a supply condition and delivered to the heated rolls at the selected speed.

2. Apparatus for producing thin air-cushioning material as claimed in claim 1 in which the first and second heated rollers, and the chill roller are each coated with a release material adapted to present an anti-adhesion capability to the several rollers and including a pair of nip rolls subsequent to the chill roll and disposed to carry said product to said accumulation means.

3. Apparatus for producing thin air-cushioning material as claimed in claim 1 wherein the produced air-cushioning material is advanced from the cooling roll to and through opposed pairs of nipping rollers to a severing device.

4. Apparatus for producing thin air-cushioning material as claimed in claim 1 wherein the cooling roll is cooled by air flow produced by a blower and delivered to said roller having through conduit means for carrying the flow of air.

5. Apparatus for producing thin air-cushioning material as claimed in claim 1 wherein the air-cushioning apparatus is carried within and by a protective enclosure or case so that driving components are not exposed to an attendant and the like.

6. Apparatus for producing thin air-cushioning material as claimed in claim 1 wherein the periphery of the forming roller is additionally cooled by a blower moving a selected quantity of air to and toward the forming roller.

7. Apparatus for producing thin air-cushioning material as claimed in claim 1 in which the multiplicity of cavities is disposed in aligned rows, with the inner ends of the cavities open to longitudinal conduits, with each conduit having a distal end thereof closed with a plug means and with the other end of these conduits coming in the way of an end plate in which is formed an arcuate pathway in flow communication with the end of a conduit and with this pathway in flow communication with the vacuum supply.

8. Apparatus for producing thin air-cushioning material as claimed in claim 1 in which the forming roller has added cooling means provided by a flow of water and the like carried to and from the forming roller through a conducting passageway formed in the support shaft.

9. Apparatus for producing thin air-cushioning material as claimed in claim 8 in which the forming roller includes an outer tubular member and an inner tubular member and providing a space therebetween with the forming cavities made in this outer tubular member, and with the flow communication portion of each cavity extending into said space and a separation of said space so as to provide isolation means of one row of cavities from an adjacent row, this isolation means including a groove formed on the inner surface of the outer tubular member and between cavity rows and a groove formed in the outer surface of the inner tubular member and radially opposite the groove in the outer member, and a resilient seal member disposed in the mating groove portions to provide a dam of vacuum flow from one row of cavities to an adjacent row.

10. Apparatus for producing thin air-cushioning material as claimed in claim 9 in which the inner and outer tubular members are maintained in precise spaced array by end plates and gasket means, with each end plate having a plug portion sized to support the inner tubular member on its inner diameter, and with the vacuum distribution end member having a seal permitting a rotative motion differential of the shaft and end plate while preventing vacuum escape.

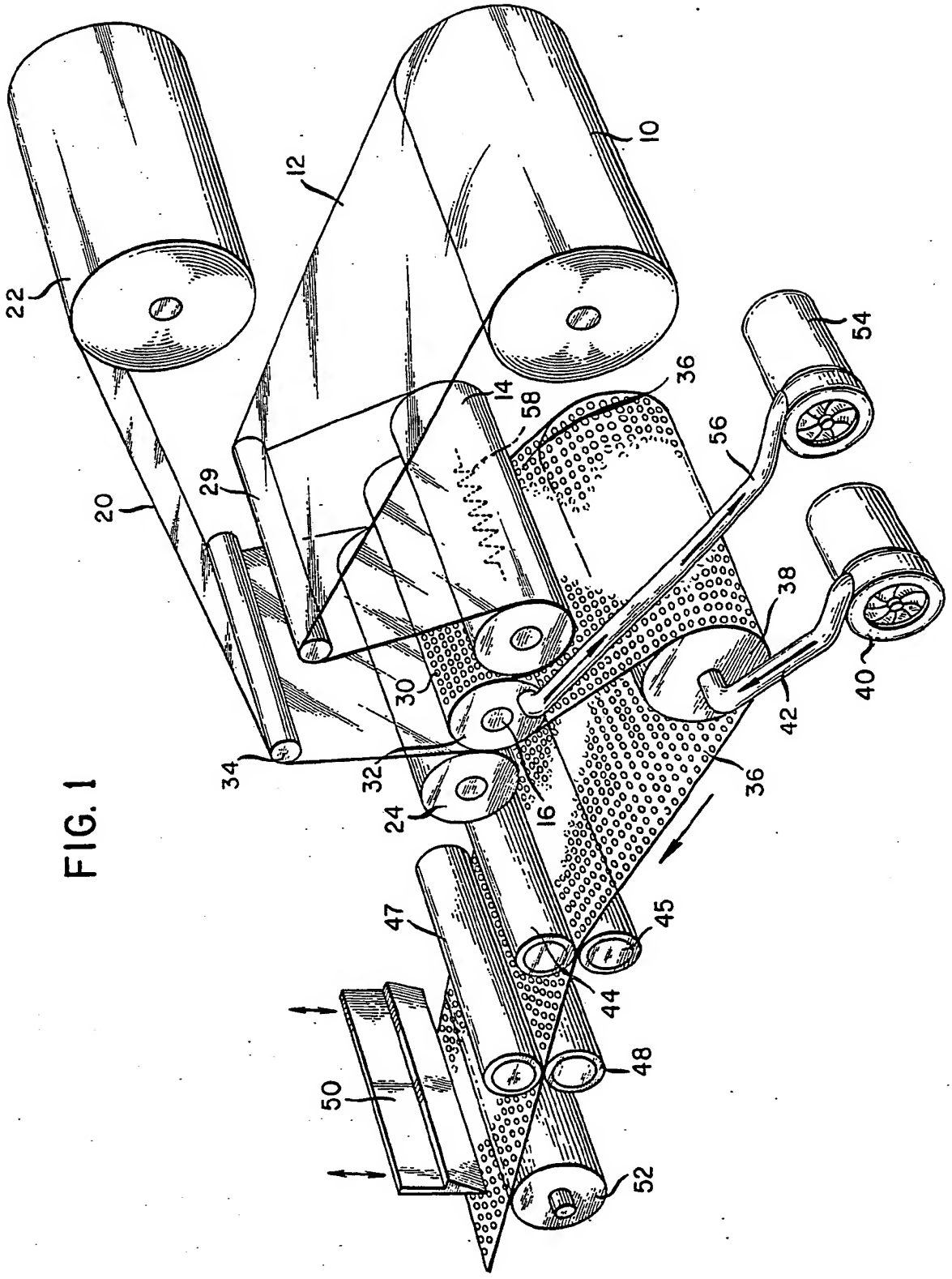

10
12
22
14
58
36
54
56
20
29
38
30
40
42
34
32
36
24
16
47
45
44
48
50
52

FIG. 1

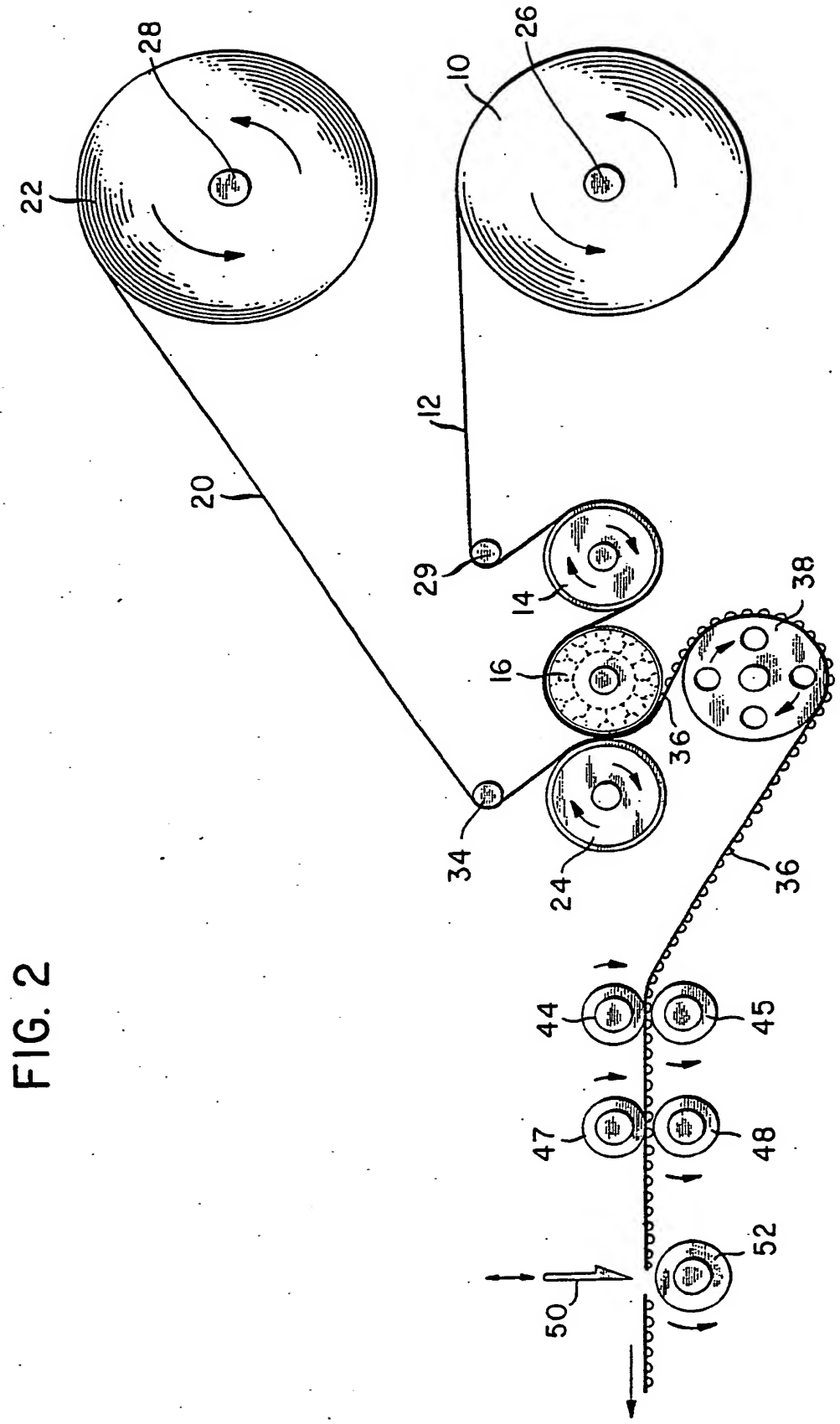


FIG. 2

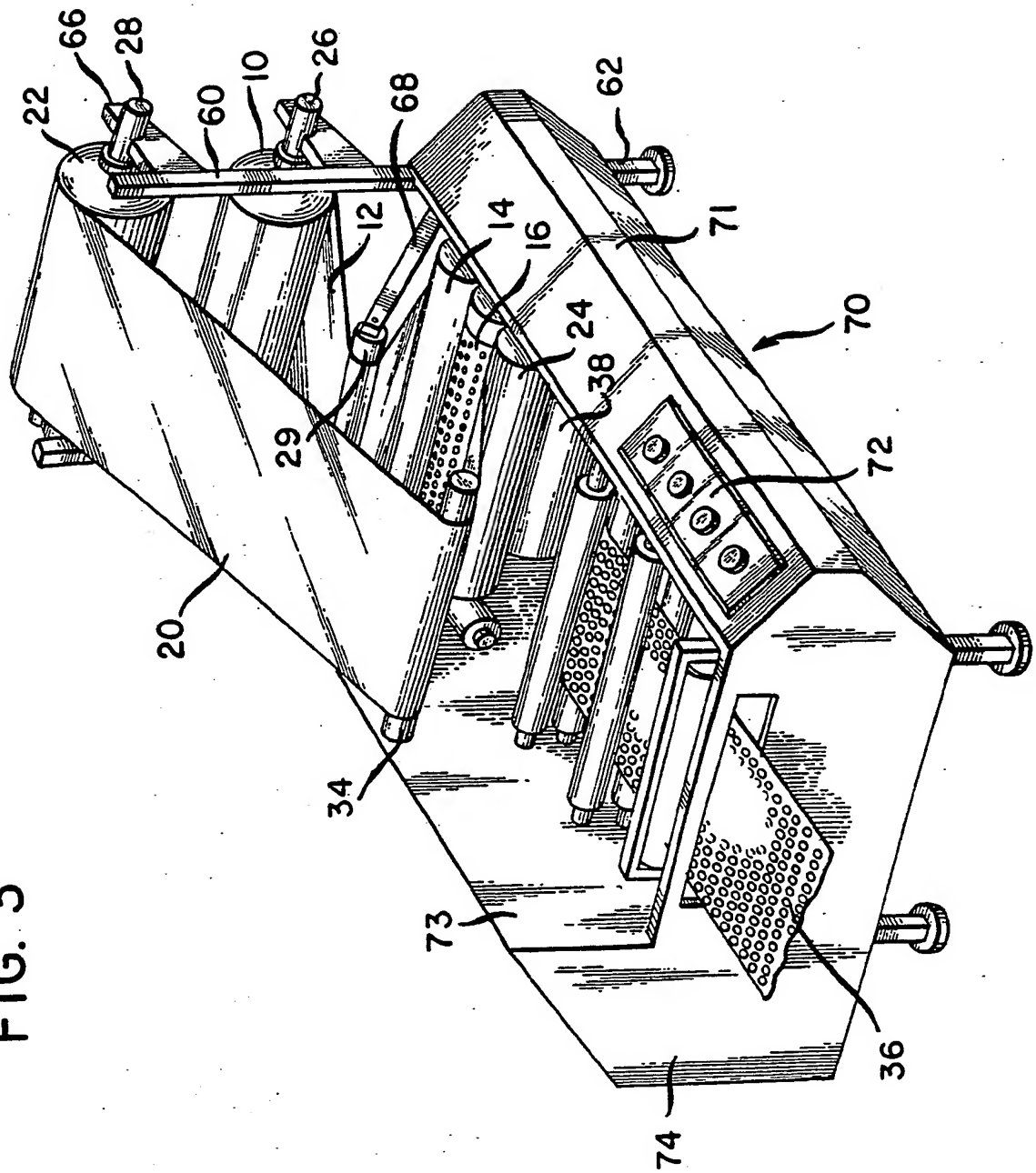
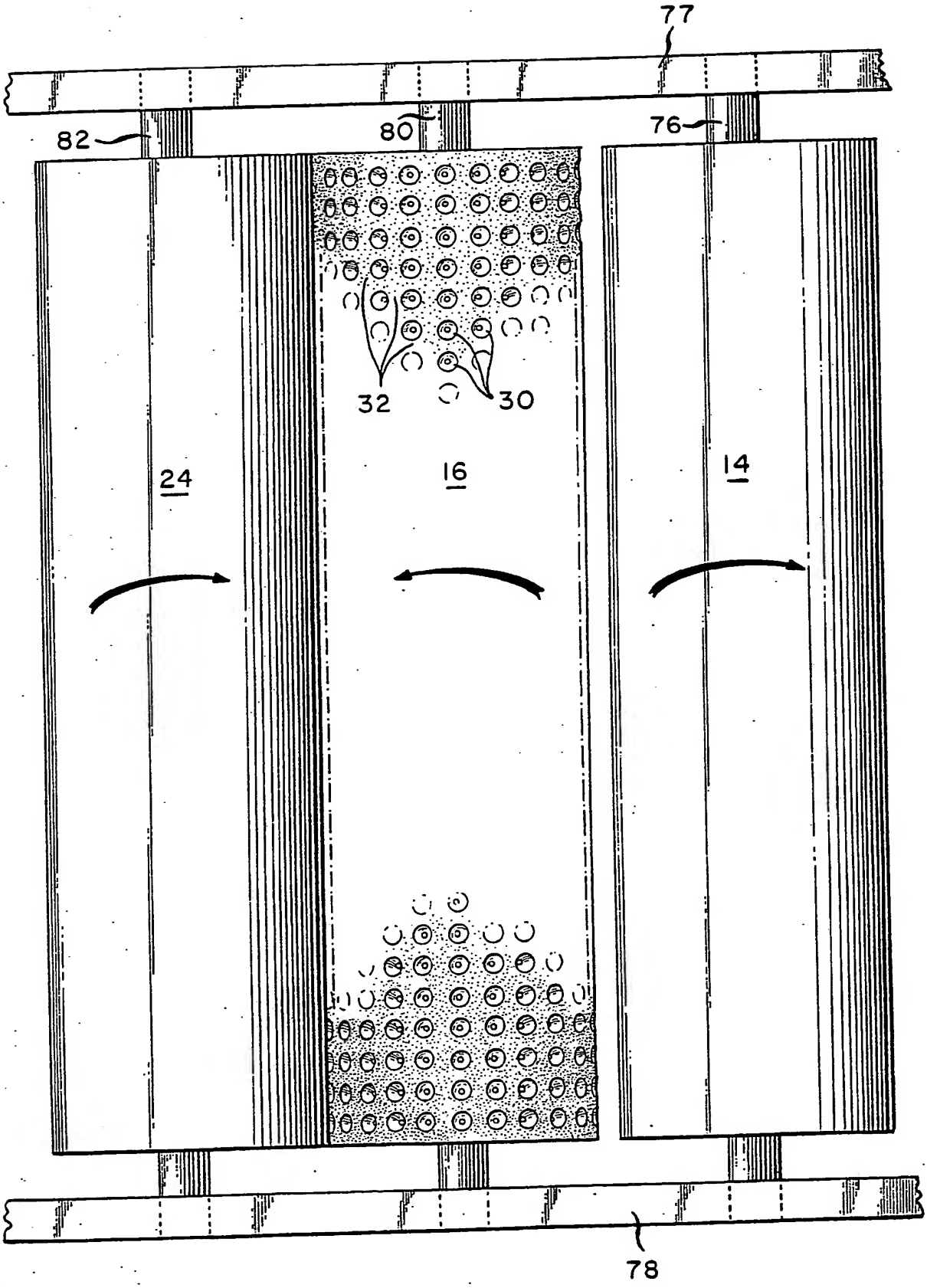


FIG. 3

FIG. 4



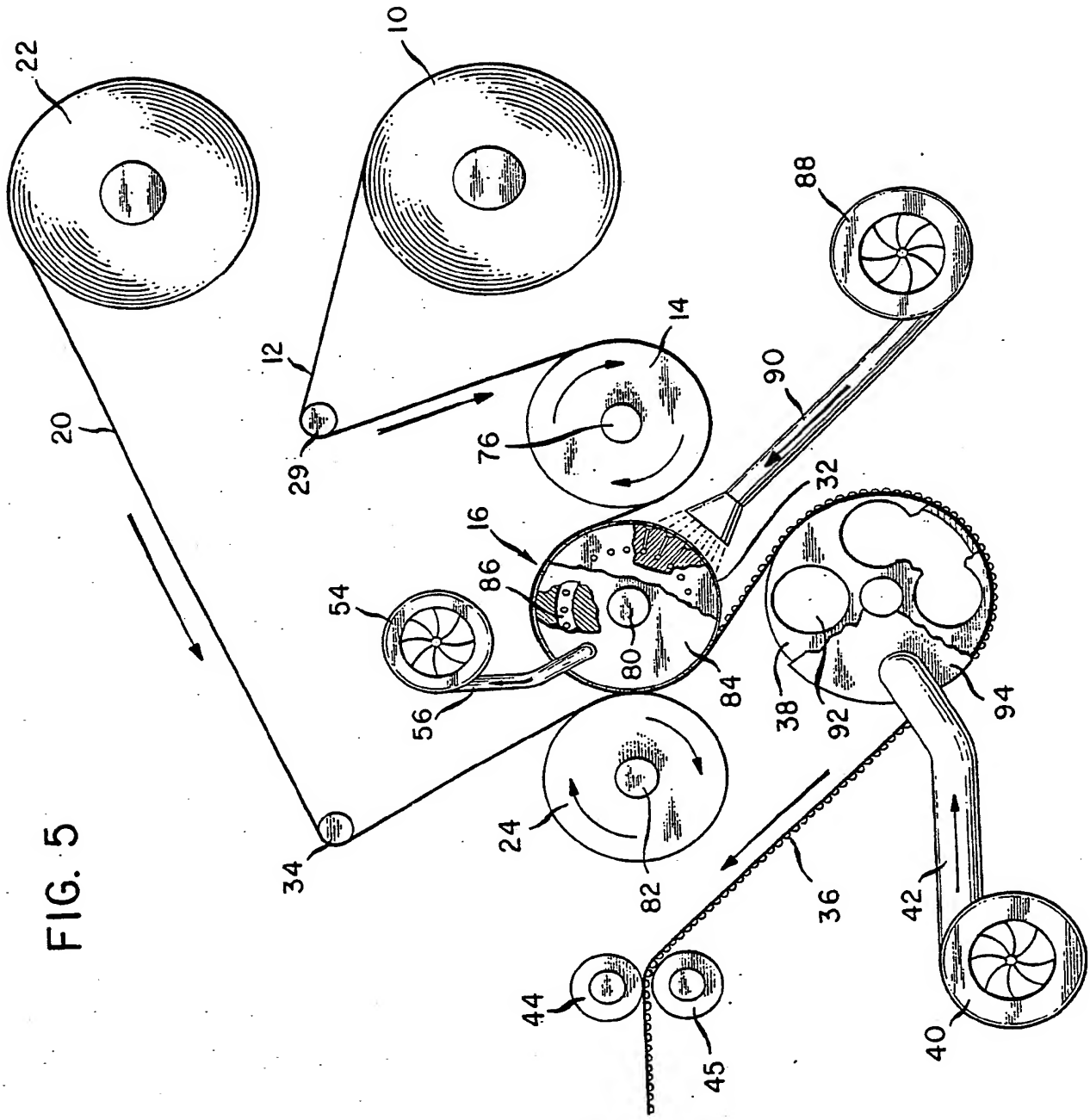
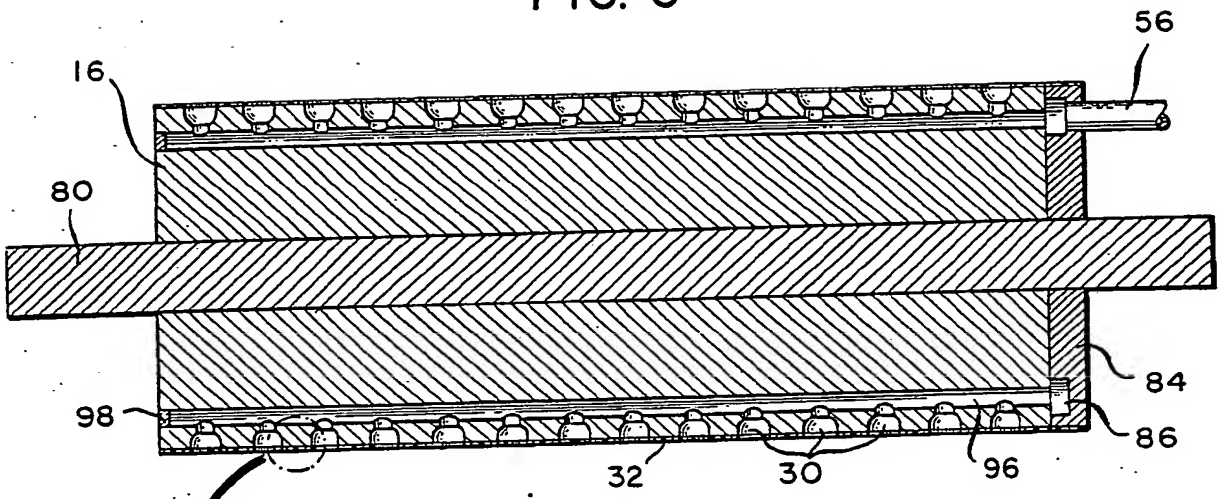

22
10
88
12
14
90
20
29
76
16
32
86
54
80
84
38
92
94
56
24
82
34
36
42
44
45
40

FIG. 5

FIG. 6



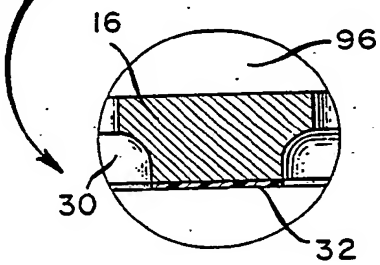


FIG. 7

FIG. 8

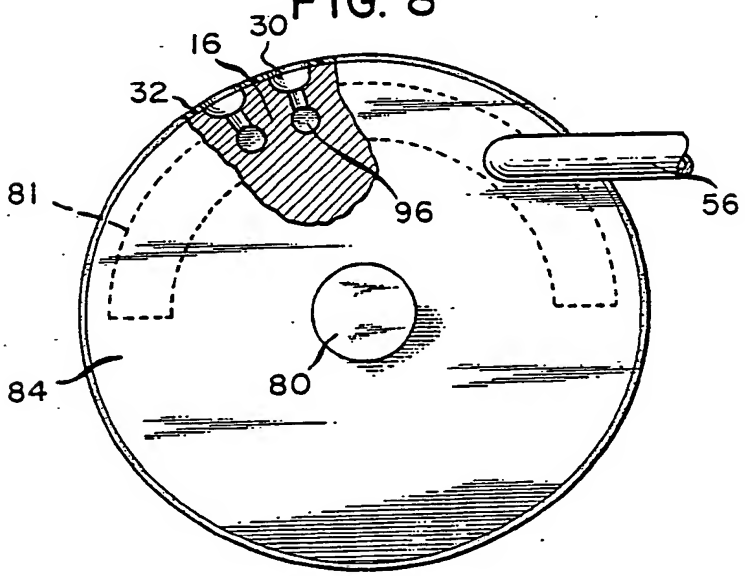


FIG. 10

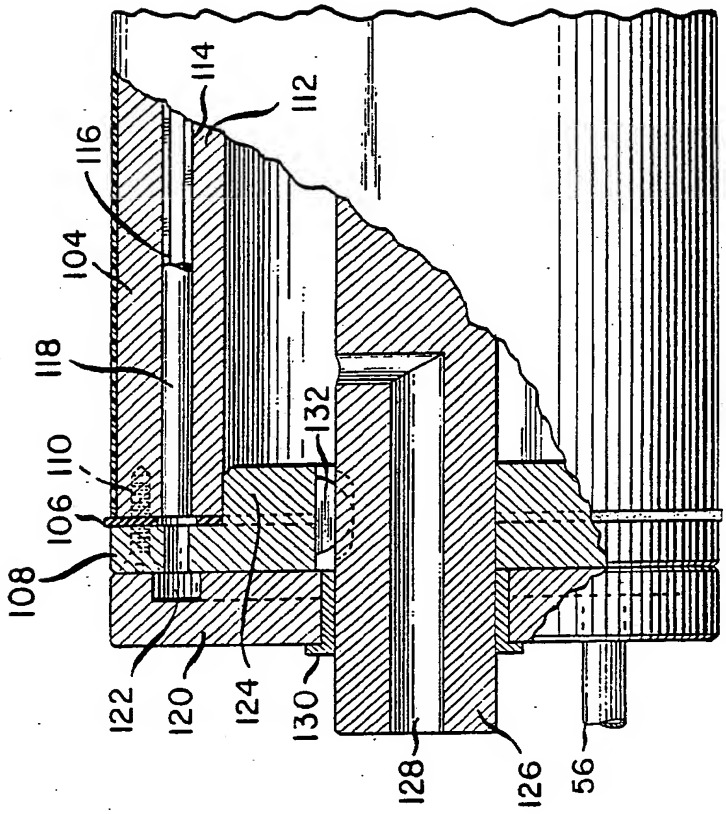
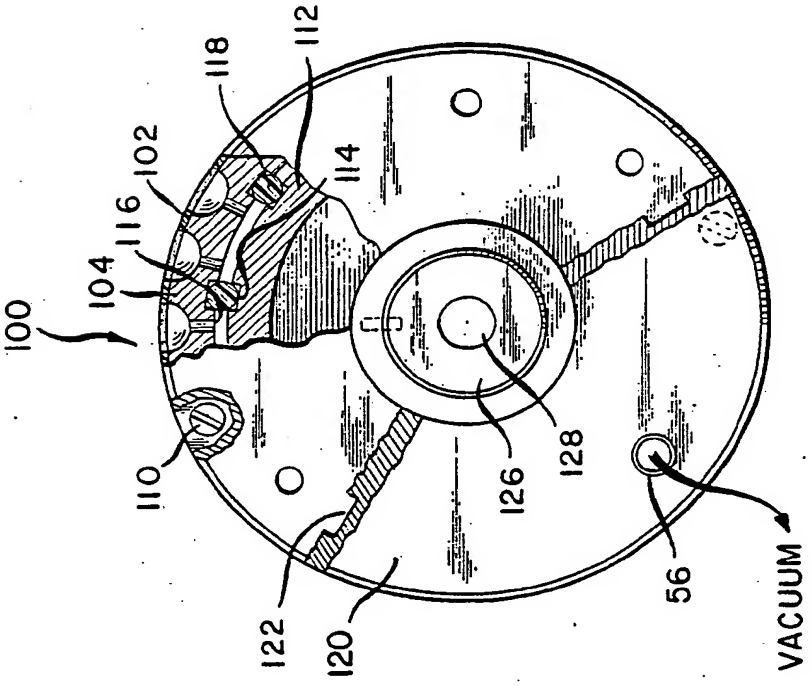


FIG. 9



INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/02494

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): B32B 31/12
US CL. 156/145; 156/498

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	156/145, 209, 289, 498; 425/388, DIG 60; 226/95

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 3,346,438 (CHAVANNES) 10 October 1967, see column 2, line 64 to column 3, line 10.	1, 2
Y	US, A, 3,392,081 (CHAVANNES) 09 July 1968, see column 5, lines 5 to 21.	1, 2
Y	US, A, 4,576,669 (CAPUTO) 18 March 1986, see entire document.	1
Y	US, A 3,655,486 (HAGINO, ET AL) 11 April 1972, see column 4, lines 68 to 75 and column 5, lines 14 to 41.	1, 5, 6
Y	US, A, 3,660,189 (TROY) 02 May 1972, see column 10, lines 19 to 37.	1, 2
Y	US, A, 4,579,516 (CAPUTO) 01 April 1986, see entire document.	1, 7, 8

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
17 September 1988	22 NOV 1988
International Searching Authority	**Signature of Authorized Officer**
ISA/US	JEFF AFTERGUT

Form PCT/ISA/210 (second sheet) (Rev.11-87)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	US, A, 3,082,925 (MACNEILL, ET. AL.) 26 March 1963, see column 5, lines 3 to 20.	1, 9, 10
Y	US, A, 3,440,125 (LINDH, ET. AL.) 22 April 1969, see column 2, lines 2 to 6.	4
Y	US, A, 4,412,879 (OTTAVIANO) 01 November 1983, see column 8, lines 27 to 32.	1, 3